

Peter

Bill K.

Fred

JPRS 84408

26 September 1983

ILLEGIB

USSR Report

MATERIALS SCIENCE AND METALLURGY

01 OCT 1983

No. 92

FBIS

FOREIGN BROADCAST INFORMATION SERVICE

ALUMINUM AND ITS ALLOYS

UDC 620.178.38:539.43

CYCLICAL FRACTURE TOUGHNESS OF ALUMINUM ALLOY K_{Ics}

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 19, No 3,
May-Jun 83 (manuscript received 11 Jan 82) pp 43-46

KUDRYASHOV, V. G.

[Abstract] The hypothesis of Irwin that fracture occurs when the stress intensity factor reaches the critical value K_{Ic} was confirmed in evaluating the strength of various structures of quasi-brittle materials operating under long-term static loading or smoothly and rather slowly changing loading. It can be assumed that in fatigue fracture, failure occurs when the maximum stress intensity factor of the cycle at the tip of the fatigue crack reaches the critical value K_{Ifc} . The greatest difference of K_{Ifc} from K_{Ic} is observed

where $R=0$, when practically the entire plastic zone before fracture is a cyclic plastic zone determined by the value of ΔK . With an intermediate cycle asymmetry factor, the plastic zone is formed under the influence of constantly increasing mean stress intensity factor of the cycle K_m and simultaneously increasing ΔK . Figures 1; references 5: 4 Russian, 1 Western. [156-6508]

UDC 669.71:669-131

HIGH STRENGTH MALLEABLE ALUMINUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 13-16

TKACHENKO, Ye. A., FILIPPOVA, Z. G. and KHOL'NOVA, V. I.

[Abstract] The production of stronger alloys than D16 duralumin type Al-Cu-Mg alloys required the study of new systems with greater solid solution areas in which the solubility of the elements introduced to the aluminum changes with a decrease in temperature. New high strength alloys with better mechanical properties have been obtained by using Al-Zn-Mg-Cu systems. A number of such alloys are described, including V95 (developed in 1948), V96TS (1956), V96TS-1 (1968), V96TS-3 (1970), V93 (1957), V95pch (1971), V95och (1971) and V93pch (1971). The chemical compositions of these alloys are presented in tabular form. Their corrosion resistance, influence of copper content on mechanical properties of aluminum alloys and influence of magnesium content on ductility are traced. Figures 3; references 8: 7 Russian, 1 Western. [157-6508]

UDC 539.4:677.494

ANALYSIS OF MODELS FOR CALCULATION OF ACHIEVEMENT OF STRENGTH BY ARAMIDE FIBERS IN THREADS AND MICROPLASTICS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83
(manuscript received 9 Nov 92) pp 387-390

KOMPANIYETS, L. V., POTAPOV, V. V., GRIGORYAN, G. A., KUPERMAN, A. M.,
PUCHKOV, L. V. ZELENSKIY, E. S., BERLIN, Al. Al., PRUT, E. V., and
YENIKOLOPYAN, N. S., Institute of Chemical Physics, USSR Academy of Sciences,
Moscow

[Abstract] Based on the statistical theory of strength, models are studied for calculation of the achievement of strength characteristics of aramide fibers in untwisted thread and microplastics. Threads and microplastics were tested either in paper frames or without them. The σ - ϵ deformation diagrams of threads and microplastics were obtained on an Instron-1122 test machine. Modulus of elasticity was determined from the initial slope of the diagrams. It was found that the diagram is initially linear, the slope tangent decreasing slightly before failure. It was found that the strength of microplastics can be determined based on the model of accumulation of damage. The degree of achievement of the potential strength of fibers in the microplastics is virtually independent of the initial level of aramide monofilament strength of the nature of the epoxy binders used for a given variational coefficient of monofilament strength. Figures 2; references 11: 9 Russian, 2 Western.
[158-6508]

UDC 620.1:678

INFLUENCE OF PROTON-ELECTRON BOMBARDMENT ON PROPERTIES OF DISPERSELY REINFORCED COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83
(manuscript received 10 Dec 82) pp 552-554

KONONENKO, V. G., deceased, MARKUS, A. M., KOBRIN, V. N., VELICHKO, N. I.,
and UDOVENKO, V. F., Khar'kov Aviation Institute imeni N. Ye. Zhukovskiy;
Physico-Technical Institute of Low Temperatures, Ukrainian Academy of
Sciences, Khar'kov

[Abstract] A study was made of the resistance of dispersely reinforced materials to the effects of proton and electron bombardment under deep vacuum conditions. The objects of the study were composite specimens of two compositions containing heat treated finely ground basalt as the filler, epoxy-organosilicon resin DFM-135 plus L-20 curing agent or sodium silicate plus 2% sodium fluosilicate as the binder. The specimens were cubes with rib length 0.01 m. Studies were performed in a high vacuum cryogenic chamber with the specimens in a special holder. An ionic HF source and electron gun supplied the corpuscular radiation. An electrostatic scanning system allowed

the specimens to be irradiated over areas of up to 100 cm^2 . Specimens were bombarded by electrons and proton beams at doses of 10^{14} - 10^{16} particles per square centimeter. Visual examination showed darkening of the specimens, increasing with increasing radiation. The darkening is an oxidative process in the binder. Study of the microstructure of the epoxy-organosilicon binder revealed a boundary between the proton-bombarded and nonbombarded zones. Significant changes in mechanical properties were observed, resulting from the formation of microfissures on the irradiated surface, which developed into macrofissures upon deformation. Figures 4; references 4: all Western.
[158-6508]

UDC 620.178:678

EXPERIMENTAL STUDY OF THERMAL CYCLING LOADING OF DISPERSELY REINFORCED COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83
(manuscript received 10 Nov 82) pp 457-459

UDOVENKO, V. F., KOBRIN, V. N., YEL'CHANINOV, V. P., GRECHKA, V. D. and KUSHNARENKO, S. G., Khar'kov Aviation Institute imeni N. Ye. Zhukovskiy; Physico-Technical Institute of Low Temperatures, Ukrainian Academy of Sciences, Khar'kov

[Abstract] A study is presented of the influence of thermal cycling on the strength properties of composite specimens of three compositions in the 140 - 135°C area for 60 cycles under deep vacuum conditions. The specimens were cubic in shape, rib length 0.01 m . The filler in the specimens was heat treated finely ground basalt, the binder was epoxyorganosilicon resin type DMF-135 plus a curing agent; sodium silicate plus 2% sodium fluosilicate; orthophosphoric acid (specimens a, b and c). The macrostructural studies showed that after thermal cycling in a deep vacuum the binder substances were sublimated from the surface of the specimens, revealing the mineral particles. Compressive strength testing revealed that deep vacuum decreases compressive strength of epoxy-organosilicon binder specimens by 0.97%, thermal cycling additionally decreases it by 7.18%. The greatest influence on strength property loss in the "a" specimens is that of the cyclical temperature drop, for specimens "b" the most important weakening factor is vacuum. The compressive strength of specimens "c" drops slightly both as a result of vacuum (by 0.45%) and as a result of vacuum plus thermal cycling (by 1.21%). Figures 3; references 5: all Russian.
[158-6508]

UDC 539.3:677.4

INELASTIC DEFORMATION OF CERTAIN HIGH MODULUS REINFORCING FIBERS

Riga MEKhanika KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 83
(manuscript received 25 Oct 82) pp 391-394

ZOSIN, L. P., VERKHOVETS, A. P., KUZ'MIN, V. N., LEVIT, M. R., LELINKOV, O. S.
and PEREPELKIN, K. Ye., Leningrad Branch, All Union Scientific Research and
Planning Institute of Artificial Fiber

[Abstract] High-strength composite materials are increasingly reinforced with superstrong and superhigh modulus organic fibers based on parapolyamides such as Kevlar. These fibers have amorphous-crystalline structure with three-dimensional ordering of crystalline areas. In spite of the great rigidity of the molecular chains and strong intermolecular interaction, the fibers are characterized by forced elastic deformation, limited slip and slow relaxation even at room temperature. Kevlar yields a clear high angle reflex diffractogram of several orders in the meridional, equatorial and diagonal planes, allowing the elastic properties of crystallites to be studied easily. The phenomenon of inelastic deformation under cyclical loading was studied by mechanical hysteresis using a universal instron-1195 test machine. The deformation rate was 10 mm/min for specimens with a base of 100 mm. Acoustical measurements of dynamic elasticity modulus were performed at 50 KHz. The molecular mechanism of deformation was studied by an x-ray diffraction method. The studies showed that in superhigh modulus organic fibers inelastic deformation phenomena accompanied by notable hysteresis are characteristic, obviously related to the inhibition of conformation transitions. This phenomenon is based on the significant potential barriers of rotation and strong intermolecular interaction allowing only cooperative conformation transitions in response to mechanical stress near the fracture stress. Figures 5; references 16: 12 Russian, 4 Western.
[158-6508]

containing 2.1% Cu, 1.6% Mg, 1.1% Fe, 0.9% Ni, 0.17% Si and 0.05% Mn. Strips were pressed at 0.8 to 0.85 m/min, ingot temperature 470°C or 370°C (1 and 2). Container temperature was 400 and 350°C. The microstructure of templates in the hardened state showed that both strips had fine grain structure. Comparative studies of the material with various grain characteristics were performed. Aging kinetics were determined on the basis of short-term tensile strength and yield point. Endurance limit at 10^7 cycles, gage section diameter 10 mm with 0 extension was determined. Fatigue testing showed that σ_{-1} is greater in the transverse direction than in the longitudinal direction, endurance limit being virtually independent of grain size. The maximum strength properties were 10 to 20 MPa less for large grain specimens than for small grain specimens. Fracture toughness of specimens with large grain structure was greater than for small grain structure, apparently a result of the greater volume of plastically deformed zones in the large grain material. Figures 5; references 14: all Russian.
[157-6508]

UDC 620.18:620.17:669.71

INFLUENCE OF STRUCTURE AND PROPERTIES OF INGOTS ON QUALITY OF V95pch ALLOY SLABS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 7, Jul 83 pp 16-19

ZASYPKIN, V. A., LESHKOV, V. P., RUCHYEVA, N. V., SETYUKOV, O. A. and
TSYPLUKHIN, I. P.

[Abstract] Aviation technology uses monolithic structures of large slabs, requiring slabs of up to 2 m in width. Ingots with a cross section of 400 x 2140 mm have been produced from V95pch and V95och alloys for the first time for this purpose. The alloys were melted in an induction furnace and an electric mixer and poured by a semicontinuous method at 40 to 45 mm/min, temperature of metal in mixer not over 700°C, in trough not over 672°C. The metal was refined on the path to the crystallizer by means of a titanium getter, a device with liquid flux and two glass screen layers with 0.6 and 0.4 mm apertures. The ingots were homogenized by heating to 465°C, holding 24 hours, cooling in air. The macrostructure of the ingots produced was fine grained, uniform through the cross section without crystal fans. The chemical composition of the $Al_7(Cr, Mn, Fe)(Cu, Zn)$ particles by microscopic x-ray spectral analysis are presented. The temperature interval of crystallization of Al_7Cr particles in V95ph specimens was determined. Microstructural studies showed that the intermetallide particles which precipitate on the bottom of the ingot are formed only after isothermal holding at 645°C, 8 to 10° C above the liquidus temperature. The results presented of studies of the structure and mechanical properties of rolled slabs 2 m wide indicate that they can be used in new aircraft structures. Figures 7; references 4: 1 Russian, 3 Western.
[157-6508]